The Structure and States of Matter
Teacher Background Information (SC100100)

Some students may know a significant amount about phase changes. If so, these lessons will be a review for them. This topic is covered in SCoPE Grade 6 Unit 4 and Grade 7 Unit 3. However, do not overestimate their backgrounds. Many misconceptions abound in this area:

- Students often confuse the concepts of volume and density. Try to avoid mentioning density casually. Begin by reviewing it from the approach of a "fair test"—comparing the mass of equal volumes. Review each time you encounter the topic, because comprehension of this concept can be ephemeral.

- Students have a great deal of trouble understanding that most of the volume of a substance is empty space—even solids. Molecules of a solid are held together by a force of attraction among the molecules, this keeps them in a rigid array or regular pattern. Molecules in a liquid move rapidly enough to slide past each other, allowing the liquid to "pour" and flow downhill. You can put your hand through liquid because the molecules can move out of the way. In a solid, the molecules are locked in a pattern or array, and cannot move. Molecules in the gas state are far apart and constantly moving so fast that when they happen to hit another molecule, the inter-molecular force cannot hold them together. The distance between molecules of a gas is much, much larger than the molecules themselves. That is why you cannot see the gas.

- Students may firmly believe in a linear, direct relationship between energy (in) and temperature (increase). The idea of heat of vaporization (Lesson 10) is counterintuitive, even for intelligent secondary students. Spend some time on this lesson, and expand it (by boiling water with some solutes in it) as your time permits.

- The polarity of water molecules gives this substance a number of unique properties. The electronegativity of the oxygen molecule causes the electrons (on average) to be more attracted to that end of the molecule. We call the molecule *polar* because it ends up with a slightly negative end and two slightly positive ends. The resulting attraction between the slightly negative ends of one molecule and the positive ends of the other is called a *hydrogen bond,* a weak chemical bond that causes the group of molecules to form ice crystal structures. The resultant crystal structure is a hexagon. Students may have "overlearned" the idea that all bonds are either ionic or covalent in middle school, and so you will be faced with dispelling a school-made misconception.

The physical changes studied in this unit result from changes in the intermolecular forces among atoms and molecules in substances. In general, your students will have only studied forces within molecules.

In most of the lessons, we have referred alternatively to “particles” and “molecules.” This is a unit that every secondary student should be able to understand and enjoy. You can accomplish sound benchmarks by using the terms “particles” if your class has not yet examined the structure of molecules in detail. In fact, if you are not fairly confident of their understanding of molecules and bonds, the use of the term “particles” is preferred.

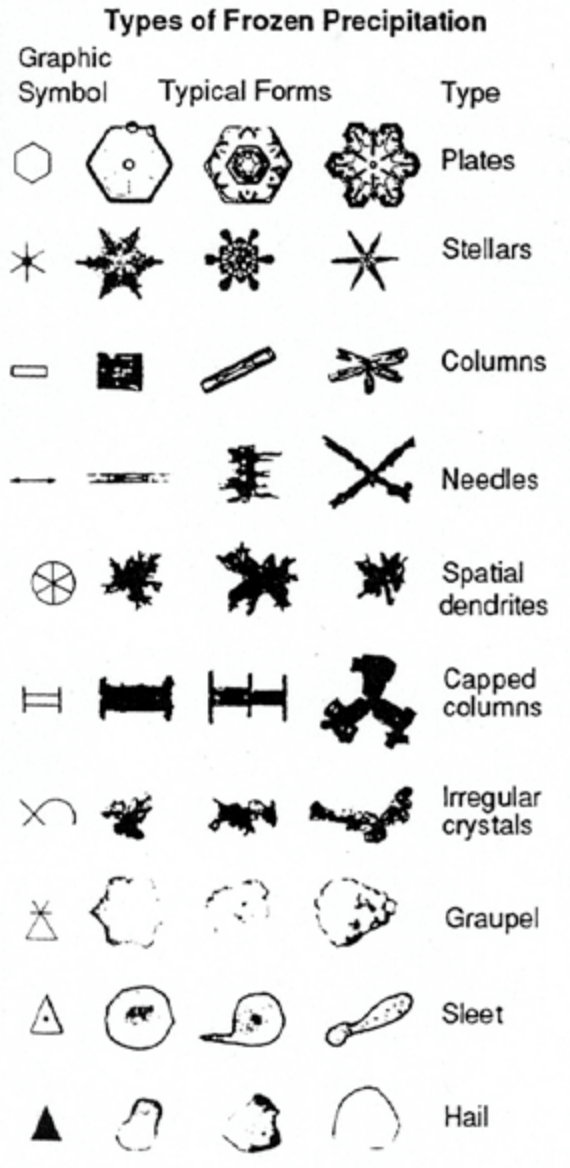
Safety Precautions

As in any chemistry lesson, every safety precaution cannot be spelled out in every lesson. For example, in Lesson 10 we have included the precaution to “follow your teacher’s directions with respect to Bunsen burners.” We have assumed that you will have taught their operation and rules previously and evaluated students on this concept.

Under no circumstances should students be making anything to eat (like “Rock Candy”) in the laboratory or in laboratory glassware. Lesson 8 provides a good opportunity to team with your Foods teacher or with your parents in an at-home activity.

Types of Crystals

FIGURE 2. The crystal formation chart.



The origin and shape of an ice crystal in a cloud basically depends on the same factors that determine its growth: temperature and availability of water vapor. The amount of each type of snow crystal varies greatly with the conditions under which it is formed.

The simpler types of crystals--columns, needles, or hexagonal plates--occur most frequently at high altitudes. Less water vapor is available at higher altitudes, which limits the growth of the crystals. These crystals can form at very low temperatures and, due to the lower atmospheric pressures at these altitudes, at relatively warm temperatures (near freezing).